

REMARKS

Claims 1-18 are all the claims pending in the application.

Claims 1-18 have been rejected under 35 U.S.C. §103(a) as obvious over U.S. Patent Application Pub. 2003/0044603 to Morita et al.

Applicants submit that Morita et al do not render obvious the subject matter of the present invention and, accordingly, request withdrawal of this rejection.

The present invention as set forth in claim 1 is directed to a crimped carbon fiber having a multilayer structure comprising an inner layer part and an outer layer part with a hollow structure in the inside thereof, the inner layer part having a carbon structure containing a herringbone structure, the outer layer part having a carbon structure differing from the carbon structure of the inner layer part.

The present invention as set forth in claim 11 as amended above is directed to a method for producing a crimped carbon fiber claimed in claim 9, which is a crimped carbon fiber according to claim 1, and wherein the carbon fiber is a vapor grown carbon fiber. The method comprises contacting a carbon source and a catalyst source with a sulfur source in a heating zone to produce a vapor grown carbon fiber, wherein the ratio of the molar number of sulfur atom in the sulfur source to the molar number of a catalyst metal atom of the catalyst source is 2.0 or more, and wherein the sulfur atom in the sulfur source has a vapor-phase concentration of 0.0001 mol/NL or more in the heating zone. Thus, applicants have amended claim 11 to incorporate the recitations of claim 12. Applicants have canceled claim 12.

The Morita et al U.S. application that the Examiner cites corresponds to JP-A-2003-73930 that is discussed in the present application at, for example, page 3, line 36 to page 4, line 10 of the present specification. As can be understood from this discussion of the present specification, the carbon fiber of Morita et al is a linear carbon fiber, that is, it is a straight carbon fiber.

In contrast, the carbon fiber of the present invention is a crimped fiber, as shown in Fig. 1A and Fig. 1B of the present specification, especially Fig. 1B.

The difference in the shape or form of the fiber of the present invention from that of Morita et al is clear.

The difference in the shape or form of the fiber in the present invention from Morita et al results from a largely excess amount of a sulfur compound used in the fiber production process of the present invention. See the discussion at page 21, line 18 to page 22, line 11 of the present specification.

Morita et al mention in Example 1 that 0.5 % by mass of sulfur was added to a raw material, and the carbon fiber was produced from the thus-produced raw material through a method similar to that described in Japanese Patent No. 2,778,434 was used. See paragraphs [0075] to [0077] of Morita et al.

The Example in paragraph [0015] of Japanese Patent No. 2,778,434, a copy of which is attached hereto, is as below:

EXAMPLE

As shown in Fig. 1, the top of vertical-type furnace 1 (inner diameter: 17.0 cm and length: 150 cm) was equipped with spray nozzle 2. The temperature of the inner walls of furnace 1 was raised and kept at 1200°C and 20 g/min of a liquid raw material of benzene containing 4% by weight of ferrocene with hydrogen at a flow rate of 100L/min was supplied in such a manner that it was directly sprayed and scattered onto the furnace walls. Spray nozzle 2 had a shape of a cone side wall (a shape of a trumpet or an umbrella) and the apex angle of the nozzle was 60°. Under these conditions, ferrocene was thermally decomposed to produce fine iron particles, which acted as seeds to thermally decompose benzene to carbon and grow carbon fibers. Carbon fibers by the above vapor process were scratched off from the walls at every 5 minutes for 1 hour to obtain the vapor grown carbon fibers. Microscopic photograph of the carbon fibers at a magnitude of 5000 is shown in Fig. 3. About 3 g of carbon fibers from the obtained carbon fibers were subjected to a heat treatment at 2400°C and mixed with a polypropylene resin (SMA410 produced by Showa Denko K.K.) to produce a fiber reinforced plastics containing carbon fibers at 50 wt%. The volumetric resistivity of the fiber reinforced plastics was measured to be 0.14Ω.

In the above Example of Japanese Patent No. 2,778,434, since 20 g/min of a liquid raw material was supplied with hydrogen at a flow rate of 100L/min, the vapor phase concentration of sulfur atom (mol/NL) can be calculated in accordance with the description on page 23, lines 22-27 of the present specification as follows.

In Example 1 of Morita et al, the amount of sulfur supplied is as follows:

$$= 0.5\% \text{ by mass} \times 20 \text{ g/min}$$

$$= 0.1 \text{ g/min}$$

$$= 0.003125 \text{ mol/min.}$$

The gas in the standard state is hydrogen only, and the amount of hydrogen supplied is 100L/min. Therefore, the vapor phase concentration of sulfur atom in Example 1 of Morita et al is as follows:

= (0.003125 mol/min)/(100L/min)

= 0.00003125 mol/L

= about 0.000031 mol/NL.

In contrast, the vapor phase concentration of sulfur atom supplied in the production of the crimped carbon fiber of the present invention is 0.0001 mol/NL or more. See page 23, lines 19 to 30 of the present specification. As discussed above, this amount is now recited in claim 11 as amended above.

It is, therefore, clear that the amount of sulfur atom supplied in producing the crimped carbon fiber is significantly higher in the present invention than the amount supplied in producing the carbon fiber in Morita et al. Accordingly, Morita et al do not disclose or suggest the subject matter of claim 11 as amended above.

Further, the effect of the present invention, that is, the crimped form of carbon fiber, is not disclosed or suggested by Morita et al.

Still further, Morita et al do not teach the percentage crimp and the distance between fiber terminals, as stated in claim 5, at all. These features are also clear when Fig. 1A of the present specification is referred to.

In view of the above, applicants submit that Morita et al do not render obvious the subject matter of the above claims and, accordingly, request withdrawal of this rejection.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the

Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

Sheldon I. Landsman

Sheldon I. Landsman
Registration No. 25,430

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

WASHINGTON OFFICE

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